

Claims

- [c1] 1. A system for providing regenerative and friction braking in a vehicle, comprising:
- a brake controller for determining a desired rate of deceleration from sensor outputs which are responsive to inputs from an operator of the vehicle;
 - a regenerative braking system operatively connected with said brake controller and with one or more road-wheels of said vehicle, with said regenerative braking system being commanded by said brake controller to produce a braking torque corresponding to the desired rate of deceleration;
 - a primary speed sensing system, operatively connected with said brake controller, for determining the speed and deceleration of said vehicle;
 - a primary comparator, operatively connected with said brake controller, for comparing the desired rate of deceleration with the rate of deceleration determined by said primary speed sensing system;
 - a brake monitor for receiving said sensor inputs from the operator of the vehicle, and for determining an audit range of deceleration of the vehicle;
 - a redundant deceleration sensor, operatively connected

with said brake monitor, for determining the vehicle's deceleration;

a secondary comparator, operatively connected with said brake monitor, for comparing the audit range of deceleration with the output from said redundant deceleration sensor; and

a friction braking system, operatively connected with both said brake controller and with said brake monitor, for providing additional braking in the event that the comparison results from either the primary comparator or the secondary comparator indicate that said regenerative braking system is not producing the commanded rate of deceleration.

- [c2] 2. A system according to Claim 1, wherein said brake monitor determines an audit range of deceleration of the vehicle comprising lower and upper deceleration targets, with said secondary comparator comparing the output from the redundant deceleration sensor with both of said deceleration targets.
- [c3] 3. A system according to Claim 1, wherein said primary speed sensing system comprises at least one wheel speed sensor.
- [c4] 4. A system according to Claim 1, wherein said redundant deceleration sensor comprises a g-force sensor.

- [c5] 5. A system according to Claim 1, wherein said primary speed sensing system comprises a g-force sensor.
- [c6] 6. A system according to Claim 1, wherein said redundant deceleration sensor comprises at least one wheel speed sensor.
- [c7] 7. A system according to Claim 1, wherein said sensor outputs which are responsive to an operator of the vehicle are outputs from at least one brake pedal sensor and an accelerator pedal sensor.
- [c8] 8. A system according to Claim 1, wherein said sensor outputs which are responsive to an operator of the vehicle are outputs from a brake pedal pressure sensor, a brake pedal position sensor, and an accelerator pedal position sensor.
- [c9] 9. A system according to Claim 1, further comprising an indicator for advising an operator of the vehicle that an operational anomaly is present in the regenerative braking system.
- [c10] 10. A method for operating a vehicle regenerative braking system with a system monitor and redundant control capability, comprising the steps of:
determining a desired rate of deceleration from sensor

outputs which are responsive to inputs from an operator of the vehicle;

commanding a regenerative braking system to produce a braking torque corresponding to the desired rate of deceleration;

measuring the speed and deceleration of said vehicle by means of a primary speed sensor;

comparing the desired rate of deceleration with the measured rate of deceleration, by means of a primary comparator;

determining an audit range of acceptable deceleration of the vehicle from said sensor outputs which are responsive to inputs from an operator of the vehicle;

measuring the vehicle's deceleration by means of a redundant deceleration sensor;

comparing the audit range of deceleration with the output from said redundant deceleration sensor, by means of a redundant comparator; and

providing additional braking by means of a friction braking system, in the event that the comparison results from either the primary comparator or the redundant comparator indicate that said regenerative braking system is not producing the commanded range of deceleration.

[c11] 11. A method according to Claim 10, further comprising

the step of activating an indicator to alert an operator of the vehicle in the event that the rate of deceleration produced by the regenerative braking system, as measured by the redundant deceleration sensor, does not lie within said audit range rate of deceleration.